APPRAISAL OF THE QUALITY OF GROUND WATER IN THE HELENA VALLEY, MONTANA

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Appraisal of the quality of ground water in the Helena valley, Montana

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Abstract

Analyses of ground-water samples from the Helena valley in west-central Montana show that nitrate (as nitrogen) concentrations ranged from less than 0.1 to 6.3 mg/l (milligrams per liter) and that the median value was 0.9 mg/l. Chloride concentrations ranged from 1.4 to 120 mg/l, and the median value was 8.4 mg/l. The areal distribution of nitrate indicates that the sources of nitrate are in the valley, and that areas of high nitrate concentrations coincide with areas of dense population.

Results of bacteriological analyses of 65 samples of ground water indicate that coliform bacteria were absent.

Ten water samples analyzed for trace element content had a few moderately high concentrations of arsenic, copper, lead, and zinc.

With few exceptions, ground water in the Helena valley is of good quality and mostly a calcium bicarbonate type. Despite locally high dissolved-solids content, the water is suitable for drinking, according to standards suggested by the U.S. Public Health Service.

Introduction

Residential development in the Helena valley (fig. 1) is increasing; about 2,000 people live in the valley at present (1972) and a population of about 4,000 has been projected for 1990 (Northwest Planners Associated, 1971). Because the rate of installation of septic tanks and wells has increased during the last 15 years, many residents are concerned that their ground-water supplies may be contaminated or that the ground-water supplies may become contaminated in time. The Lewis and Clark County Commissioners and the Lewis and Clark County Planning Board requested the U.S. Geological Survey to appraise the quality of ground water in the Helena valley to help evaluate the situation.

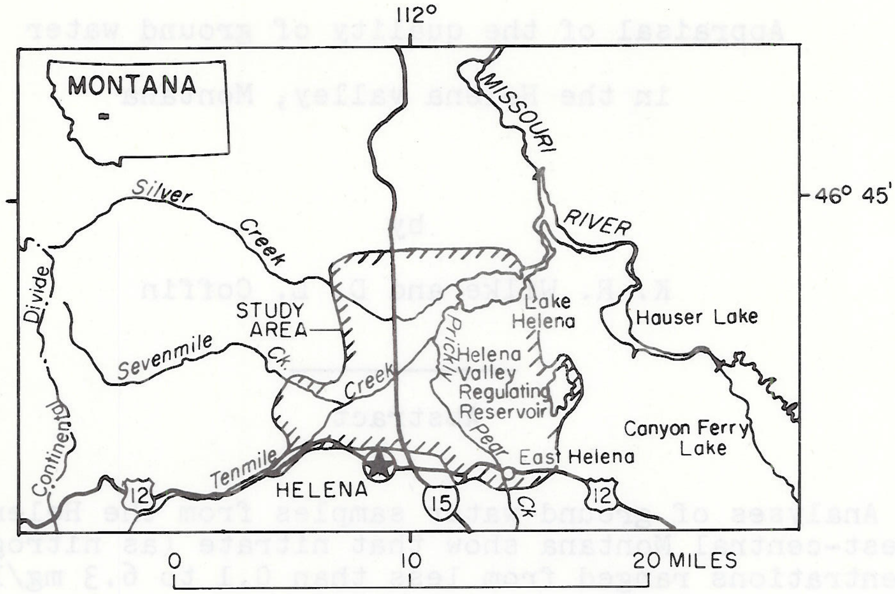

Figure 1. Study area.

Several types of contamination can result from septic-tank effluent. For example, bacteriological contamination can occur if septic-tank effluent carrying pathogens becomes mixed with ground water. Sand and gravel tend to filter micro-organisms and keep them from moving very far from their source; however, the possibility of bacteriological contamination increases where the water table is shallow, where septic systems are improperly constructed, or where conduits develop between wells and septic systems. Nitrate, ammonia, and other nitrogen compounds from septic-tank effluent can have toxic effects on man. Large amounts of nitrate in drinking water can cause nitrate poisoning in infants (U.S. Public Health Service, 1962).

Not all homes and businesses in the Helena valley have individual waste-disposal systems. Treasure State Acres (10N3W8c), Cooney Convalescent Home (10N3W18c, "County Hospital"), Fort Harrison (10N4W15), and the city of East Helena are served by sewage lagoons. Helena is served by a primary sewage treatment plant (10N3W17d), which discharges treated effluent into Prickly Pear Creek. Seepage from sewage lagoons or sewage-plant effluent contains the same nitrogen compounds as septic-tank effluent. Other sources of nitrate are accumulated animal wastes in small pastures or corrals where horses or cattle are confined, and nitrogen fertilizers applied to farm lands.

For some elements, compounds, and organisms, standards for potable water used by carriers engaged in interstate commerce have been set by the U.S. Public Health Service (1962). These standards may be used to evaluate public water supplies in the United States. The standards include limits for certain substances which, if exceeded, shall be grounds for rejection of the supplies. Limits for other substances are recommended that should not be exceeded whenever more suitable supplies are, or can be made, available at resonable cost. A copy of these standards are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, by ordering "Public Health Service Publication No. 956". A listing of the limits for substances for which analyses are included in this report follows:

Substance	Concentrations which should not be exceeded if more suitable supplies can be made available	Concentrations which shall constitute grounds for rejection of the supply
Arsenic (As)	10 µg/l[1]	50 µg/l
Cadmium (Cd)		10 µg/l
Chromium (Cr^{+6})		50 µg/l
Chloride (Cl)	250 mg/l[2]	
Copper (Cu)	1,000 µg/l	
Fluoride (F) (approximate limit for Helena valley)[3]		1.5 mg/l
Iron (Fe)	300 µg/l	
Lead (Pb)		50 µg/l
Manganese (Mn)	50 µg/l	
Alkyl benzene sulfonate (household detergent, MBAS)	.5 mg/l	
Nitrate (as N)	10 mg/l[4]	
Sulfate (SO_4)	250 mg/l	
Total dissolved solids (1,000 acceptable if no other water is available)	500 mg/l	
Zinc (Zn)	5,000 µg/l	

1/ µg/l, micrograms per liter
2/ mg/l, milligrams per liter
3/ Fluoride limits are based on annual average of maximum daily air temperatures.
4/ 10 mg/l nitrate (as N) is equivalent to 45 mg/l nitrate (as NO_3).

The purpose of this study, which began in July 1971, was to determine the quality of ground water relative to generally accepted standards for drinking water and to determine the areal distribution of constituents that are indicative of septic-tank effluent. Water-supply wells and U.S. Bureau of Reclamation observation wells were inventoried and depth to water was measured. Land-surface altitudes were taken from the Helena and East Helena 15-minute topographic quadrangles and a water-level contour map was prepared. Samples of water from selected wells throughout the valley were analyzed for inorganic chemical constituents and the presence of coliform bacteria. Analytical results are presented, and the values used to describe the quality of the ground water. A short glossary and the tables of basic data are included at the end of the report.

The cooperation of area residents and the U.S. Bureau of Reclamation in allowing water-level measurements and collection of water samples from their wells is sincerely appreciated. The study was aided greatly by the Montana Department of Health whose personnel made most of the bacteriological analyses. Keith Trafton and Dave Thomas of the City-County Health Department assisted in project planning and helped collect water samples for bacteriological analyses. Much credit is due Ron King, summer field assistant, for the well inventory, water-level measurement, and water-sample collection.

System for specifying geographic locations

Location numbers for wells or other sites are derived from the General Land Office system of land subdivision. The first three characters of the location number specify the township, the next two the range, the next one or two the section number within the township, and the next three the location within the quarter section (160-acre tract), the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). Subdivisions of a section are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one well or location in a 10-acre tract, consecutive digits beginning with 2 for the second well are added to the location number. For example, a well numbered 10N4W23bac2 would be the second well inventoried in the SW¼ of the NE¼ of the NW¼ of section 23, Township 10 North, Range 4 West. This system of specifying location is shown in figure 2.

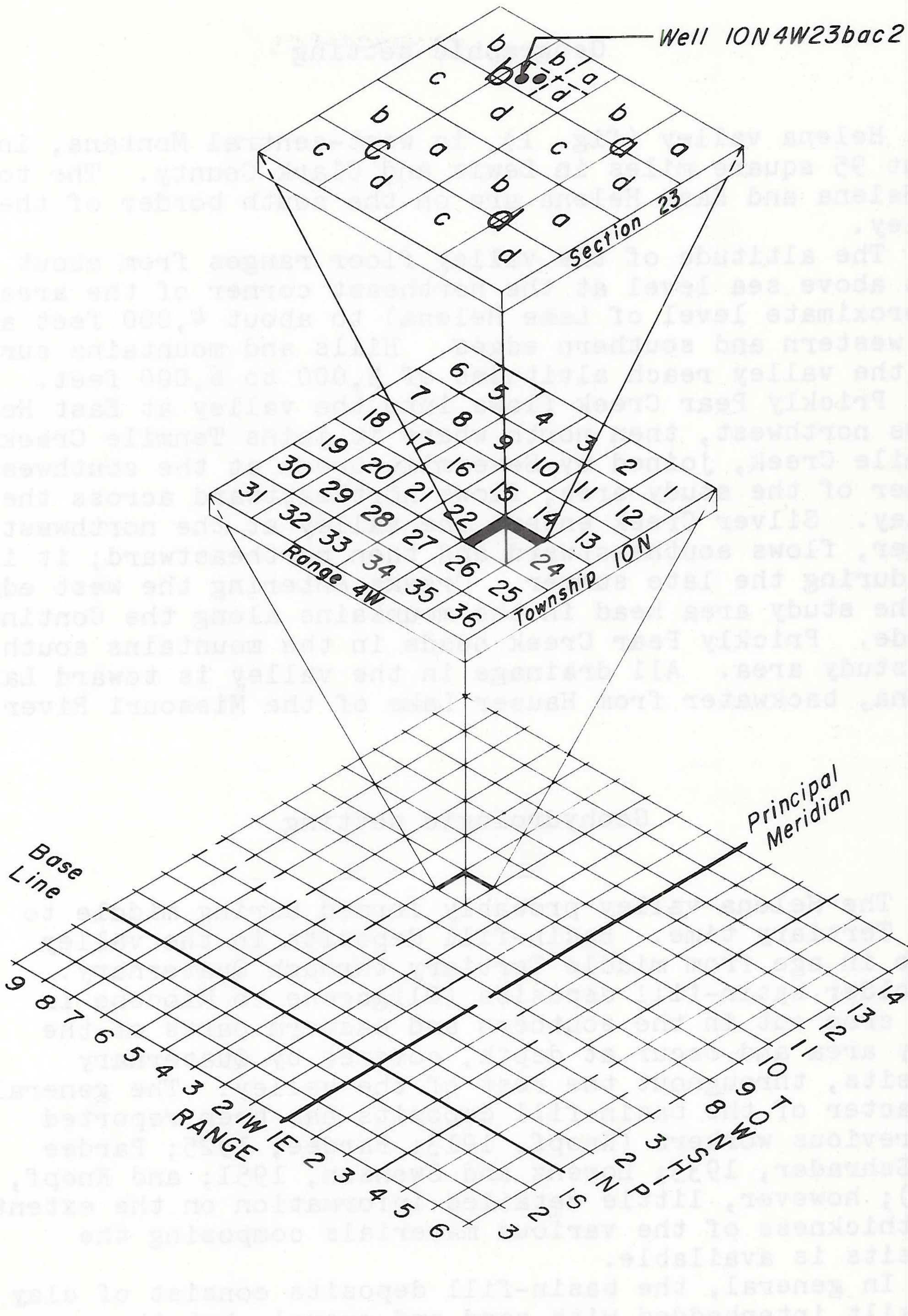

Figure 2.—System of specifying locations

Geographic setting

Helena valley (fig. 1), in west-central Montana, includes about 95 square miles in Lewis and Clark County. The towns of Helena and East Helena are on the south border of the valley.

The altitude of the valley floor ranges from about 3,650 feet above sea level at the northeast corner of the area (approximate level of Lake Helena) to about 4,000 feet along the western and southern edges. Hills and mountains surrounding the valley reach altitudes of 5,000 to 6,000 feet.

Prickly Pear Creek flows into the valley at East Helena, flows northwest, then north where it joins Tenmile Creek. Tenmile Creek, joined by Sevenmile Creek at the southwestern corner of the study area, flows northeastward across the valley. Silver Creek enters the valley at the northwest corner, flows southeastward and then northeastward; it is dry during the late summer. Creeks entering the west edge of the study area head in the mountains along the Continental Divide. Prickly Pear Creek heads in the mountains south of the study area. All drainage in the valley is toward Lake Helena, backwater from Hauser Lake of the Missouri River.

Geohydrologic setting

The Helena valley probably formed during middle to late Tertiary time. Basin-fill deposits in the valley range in age from middle Tertiary through Quaternary. The older basin-fill deposits (Oligocene to Miocene in age) crop out in the southern and eastern parts of the study area and occur at depth, covered by Quaternary deposits, throughout the rest of the valley. The general character of the basin-fill deposits has been reported by previous workers (Knopf, 1913; Pardee, 1925; Pardee and Schrader, 1933; Lorenz and Swenson, 1951; and Knopf, 1963); however, little detailed information on the extent and thickness of the various materials composing the deposits is available.

In general, the basin-fill deposits consist of clay and silt interbedded with sand and gravel, but the composition varies greatly from area to area; volcanic ash, volcanic flows, and layers of lignite are present in some places. Sand and gravel occur as discontinuous lenses, but make up a large percentage of the basin-fill deposits. The full thickness of the basin-fill deposits is not known. Water wells, reportedly drilled as much as 1,200 feet deep (Knopf, 1913, p. 94) in search of artesian water, did not reach the base of the deposits.